

## METHOD AND APPARATUS FOR IDENTIFYING AND QUANTIFYING SIMPLE AND COMPLEX CHEMICALS

This invention was made with Government support under contract number DTRS-57-85-C-00118, awarded by the Department of Transportation. The Government has certain rights in this invention.

### FIELD OF THE INVENTION

The invention relates to a method and apparatus for field analysis and quantification of simple and complex chemicals. More particularly, the invention relates to a portable apparatus for performing quick and easy identification of chemical compounds present in liquid and solid materials, and a method of using this apparatus.

### BACKGROUND OF THE INVENTION

This invention relates to analytical devices and more particularly to devices for analyzing the composition of liquids and solids in a sample. The invention further relates to a device capable of providing a plurality of individual electrical responses from a plurality of sensors with the responses forming a pattern characteristic of the components of a gas, vapor, liquid, a solid or a mixture thereof. The device is particularly useful when the plurality of responses exceeds the number of sensors as a result of operation of the sensors in different operating modes. More specifically, the invention relates to a portable instrument capable of being used in field locations for identifying the composition of at least one component in a solid, liquid or gas by first converting said solid, liquid or gas to a fluid and then by comparing the pattern of responses from the sensors to the fluid with one or more standard patterns stored in a memory in the instrument.

Particularly with respect to use at field locations for chemical spills and the like, devices for detecting the presence of a pollutant or other hazardous component in a material have generally been associated with one particular selected compound. Detection devices designed for detection of hydrogen sulfide, carbon monoxide, ammonia and the like may be considered as representative. Essentially, these devices are used to detect one or a few selected pollutants and are not designed to identify individual pollutants. When a material for analysis may contain an unknown chemical or pollutant or mixture thereof, it is usually necessary to obtain a sample of the material and send it to a remote laboratory for analysis. The time required for the transmittal of the sample and its analysis usually delays a meaningful identification of any harmful components and/or their concentration in the material for a significant time. This time delay can cause significant damage to human health, the environment and equipment.

Semi-portable versions of the more powerful laboratory gas chromatographic or infrared analyzers have been commercially introduced in recent years. These devices can respond to many chemicals and even some chemical mixtures. Besides being rather heavy, bulky, unwieldy and expensive, these instruments have certain inherent limitations. The gas chromatographic devices cannot operate in a continuous, real-time monitoring mode and require standards to be analyzed in order to identify compounds. The existing portable infrared analyzers require a delicate optical system with a rather long absorption path, which contributes to their bulk,

weight and unwieldiness. Again, these cannot perform identification in the field and the identification function is only available in complex and very expensive laboratory size infrared analyzers. In addition, these instruments must usually be operated, and their results interpreted, by well-trained professionals.

An example of a device for the detection of toxic gases in a gaseous material is disclosed in a co-pending U.S. patent application Ser. No. 585,699, and now U.S. Pat. No. 4,670,405, filed on Mar. 2, 1984, which is hereby incorporated by reference.

One object of this invention is to provide a device for detecting, quantifying, and identifying one or more components of a chemically simple or complex gas, liquid or solid material.

A second object of this invention is to provide a device capable of identifying one or more components in a gas, liquid or solid material by the comparison of the response pattern of a plurality of sensors to a standard pattern.

A third object of the invention is to provide a device for identifying any of a number of unknown components or classes of compounds in a gas, liquid or solid material such as, for example, trace trichloroethane or benzene in groundwater.

Another object of the invention is to provide a device capable of providing a varied pattern of responses and thereby capable of identifying a plurality of possible materials such as gases, pure liquids, complex liquid mixtures, organic solids, inorganic solids, and mixtures of solid organic and inorganic chemicals.

An additional object of the invention is to provide a device capable of on-site analysis of a gas, liquid or solid material.

A further object of the invention is to provide a portable device for identification of gas, liquid and solid materials which is capable of being easily transported to field locations and of being operated by unskilled or semi-skilled personnel.

A further object of the present invention is to provide a portable device into which a raw, untreated chemical may be easily and automatically introduced and subsequently be identified and quantified.

Another object of the invention is to provide a portable device in which the plurality of responses obtained exceeds the number of sensors in the device.

Another object of the invention is to provide a single device capable of performing several functions including detection, identification, quantification and monitoring for a multiplicity of chemicals and chemical mixtures.

These and other objects of the invention will become apparent to one of ordinary skill in the art from the summary and detailed description which follow.

### SUMMARY OF THE INVENTION

The invention relates to an instrument for detecting, quantifying, and identifying at least one component or class of chemicals. The instrument is capable of detecting, quantifying and identifying gases, liquids and solids. The instrument includes means for changing the gases, liquids and solids to an appropriate fluid. Once the gases, liquids and solids are changed to fluids they are introduced to sensing means comprising an array of sensors. The array includes at least two sensors having different electrical responses to the fluids dependent upon the chemical interaction of the fluids with each of the sensors. The instrument also includes means for